



#### FIN AND RUDDER

- Perhaps the best part to build first is the vertical fin. On paper, plywood, or cardboard, lay out full size the dimensions for both fin and rudder, per drawing 6. Draw in the location of all members.
- The fin spar is RS-10, and the leading edge is RS-17. Note the LEADING EDGE IS LAMINATED FROM 4 PIECES OF RS-17. ROUND LEADING EDGE AS SHOWN IN DWG. NO. 7.
- Cut the fin leading edge and spar to length. Cut two slots in the spar for the hinges, per detail "F". Note that the slots should be just long enough for the hinges to fit.
- Lay leading edge and spar on the drawing. Cut lengths of RS-17 for ribs and diagonals.
- Cut upper and lower ribs to length from RS-10. After cutting lower rib to length, drill two 3/16" holes as shown.
- Install anchor nuts with small wood screws and epoxy, per detail "J", drawing 7.
- Cut gussets from RS-533, except for the lower rear gusset (see detail "I"), which is cut from RS-535, per the cutting diagram on the right side of drawing 7. You might as well cut the lower rudder gussets at the same time, since they are cut from the same piece of RS-535.
- Lay all components on the layout drawing. Glue and staple all the components together, along with the gussets on the top side. Also cut and glue the RS-11 corner block, per the drawing.
- When glue has cured, remove from the layout and turn over. Glue and staple gussets to the other side.
- Build rudder in a similar manner, except that the trailing edge is made of RS-15 tapered stock. Before assembly, slot the rudder spar for the hinge like you did the fin spar. Also, drill two 3/16" holes in the bottom rib to attach the rudder horn, per detail "J". The lower gusset can also be slotted for the rudder horn at this time, as shown.
- Taper the rudder ribs toward the trailing edge as shown in drawing 7. Cut one rib as a pattern to mark the others.
- After fin and rudder assemblies are dry, lay both on the full size layout, with the hinges inserted in the slots (detail "F"). Don't forget the 1/32" spacers, so that the fin and rudder spars will be spaced 3/8" apart.
- Make sure the pieces are held securely with blocks or clamps, and carefully mark and drill 3/16" holes through the spars and hinges as shown in detail "F".

Now take a break and admire your handiwork.

#### STABILIZER AND ELEVATOR:

- Construction of the stabilizer and elevator is similar to the fin and rudder. Lay out all dimensions full size, per dwg. 6, including location of all members.
- The stabilizer spar is cut from RS-10 and reinforced with RS-10 doublers as shown in detail "E", drawing 7.
- Cut four slots in the stabilizer spar for hinges, as you did for the fin spar (detail "F").
- LAMINATE LEADING EDGE (RS-17) AS SHOWN. Lay leading edges and spar on the drawing.
- Cut lengths of RS-17 for ribs and diagonals.
- The center rib is RS-10. Cut to length and glue on RS-17 reinforcements as shown in detail "C", drawing 7.
- Cut lengths of RS-10 for the nose reinforcements, as shown in detail "A".
- Most gussets are cut from RS-533. The triangular leading edge gussets are cut from RS-661. Note the top centerline gusset, of RS-651, extends only to just behind the center rib reinforcement, as shown.
- Lay all components on the full size layout - glue and staple together, along with the gussets on the top side. Glue in the RS-11 corner blocks on each side.
- When glue is cured, remove from drawing, turn over, and glue and staple gussets on the bottom. Note the centerline gusset on the bottom extends the full length of the rib and mates with the RS-652 gusset at the rear.
- Elevator is similar to the rudder. Before beginning assembly, glue the elevator spar doubler as you did for the stabilizer. Also, slot the elevator spar for the hinges.
- Note the ribs are tapered, just like for the rudder.
- After both assemblies are dry, lay both on the full size layout, with the hinges inserted in the slots (detail "F"). Don't forget the 1/32" spacers, so that the stabilizer and elevator will be placed 3/8" apart.
- Make sure the pieces are held securely with blocks or clamps, and carefully mark and drill 3/16" holes through the spars and hinges as you did for the fin and rudder.

#### LANDING GEAR

The landing gear is both simple and rugged. It may be quickly removed by simply pulling the hinge pins from the mounts.

- Begin construction by gluing up the two "V" legs from RS wood and plywood, per drawing 12.
- Before gluing on the second plywood side, mark all areas that will be glue surfaces. The remaining area that will be on the "inside" of the leg is sealed with polyurethane varnish.
- After assembly, the top edge of the leg is cut at 37 degrees to fit against the fuselage bottom. This is best done on a table saw, however, with care and the use of a clamped on wood strip guide, it can be cut with

a saber saw.

- Next cut four aluminum mounting brackets from RS-200 per the drawing. Transfer holes in angles to the leg and drill. Temporarily bolt angles in place.
- Cut and drill the axle hole locating block, as shown in dwg. 12. Place it between the angle brackets. Be sure the pencil center-line shows through the 1/4 inch diameter hole on its center, then "C" clamp in place.
- Use a long 1/4 inch drill bit and drill through the guide hole in the block into gear leg.
- Remove locating block and angle brackets.
- Cut the 1-1/8 inch diameter hole with a hole saw in your drill motor, using the hole you just drilled as a guide. Cut from both sides until through.
- Locate the hinge on the gear "V". Allow the other half of the hinge to fold over the slanted edge of the leg.
- Hold hinge tight against leg and drill bolt holes. Bolt temporarily in place.
- Nail two 3/4" by 2" by 16" wood strips to bench top with outside edges exactly 24-1/4" apart and parallel to each other. These are to simulate the fuselage bottom.
- Place legs on strips with loose hinge half lying against outside vertical surface of strip.
- Temporarily attach hinge to wood strips with 2 or 3 wood screws.
- Mark and drill the axle as shown at the bottom of drawing 12.
- Slide axle tube through gear legs and insert bolts through angles and axles.
- Check to insure each end of axle is exactly the same height above bench and at right angles to centerline between strips.
- Insert an eyebolt in each leg per drawing 12.
- Cut and flatten the 1/2" diameter aluminum tubes to fit eyebolts as shown. Drill 3/16" hole in flattened end and bolt to eyebolts.
- Square up axle centerline to bench centerline and locate other end of 3/8" tubes over the holes in tube at axle center per drawing.
- Drill 3/16" holes through the 3/8" tubes to match holes in the axle. Bolt both tubes to axle.
- You now have an inverted landing gear assembly on the bench.
- Before removing, slide on the two 5/16" spacer collars. Next slide on both wheels, then the outer 1" long collar.
- Push this collar on until assembly is tight and rotate wheel. Note exact distance of edge of collar to end of axle; measure and mark collar and axle. This is necessary, since the wheel must be removed to drill end holes for the wing strut attachment, which is done with wing installed on aircraft and front strut tubes in place.
- One way to do this is to wrap a radiator hose clamp around the axle where the wheel was located, and slide it against inside face of the 1" wide collar.
- Locate collar on mark, then slide out approximately .020 to .030" for wheel bearing clearance. Relocate hose clamp and tighten. Be sure collar cannot slide in.
- Now remove assembly from bench and fit onto inverted fuselage in the position shown on drawing 12.
- Check to see that the axle is perpendicular to fuselage centerline.
- Before drilling hinge holes in fuselage, be sure the 37 degree surface is tight against the bottom of the fuselage.
- Drill and temporarily bolt gear to fuselage. Fuselage may now be turned right side up.

#### CONTROL SYSTEM

The elevator is actuated by a push-pull cable and housing system. Ailerons are similarly operated by push-pull cables. Flaps are by direct lever connection, and the rudder is controlled by wire cables.

- Drawing 5 gives details on building the control stick assembly. Parts are cut from aluminum and steel. When drilling holes in parts that rotate, be careful to keep clearance to a minimum.
- Bushing stock, RS-601 and 602, is mild steel tubing. The I.D. is slightly undersized and the O.D. slightly oversized.
- When making bushings, two methods may be used. Leave the O.D. as is and ream the hole it fits for proper fit, or chuck bushing into lathe or drill press and reduce the O.D. with a fine file and emery paper. Only a few thousandths of an inch must be removed.
- Drill out I.D. for bolt size required. These operations are performed before cutting bushings to length.
- Torque tube bearing blocks are cut from plastic bar. Use care in boring out the 1" diameter hole to avoid excessive clearance.
- End play in the torque tube is taken up by the thrust collar. Tube should rotate without undue effort, but with no end play.
- Drawing 5 gives details on aileron hook-up.
- After aileron control assembly has been installed and hooked up to the aileron, adjust cables for equal travel.
- Remove entire assembly for sealing wood with varnish, then re-install before covering fuselage.
- Drawings 11 shows hook-up of rudder and elevator systems.
- After elevator push-pull cable is installed, cut a "U" shaped piece

of 1/8" plywood, place over cable, and glue to the diagonal brace at station 5. This is to prevent the cable from swinging around inside the fuselage.

- Rudder pedals are shown on drawing 9. Fore and aft mounting distance for proper leg room is best determined by trial before mounting pedal hinges to floor board.
- Note that two cables are used. One set goes to the rudder horns and the other to the tailwheel steering arm.
- Also note that one length of cable is used, by attaching thimble and sleeve near the center, as shown at the top of drawing 8.
- Make a plastic cable guide or fairlead, as shown in drawing 9. This is attached to seat backrest and is the point where the two cables separate going to the tail.
- Tailwheel cable is routed through two plastic pipe fittings which make excellent guides. Drill a hole in each lower triangular gusset at station 8 and thread fitting in place. Epoxy threads to ensure guide does not loosen. A slot in the 1/8" plywood side strip is necessary to allow cable to pass through. Once installed permanently, the cable assembly cannot be removed, therefore, attach to steering bar with temporary cable clamps until after all varnishing is done. Steering bar must also be painted.
- Rudder cable is installed in about the same way, except cable guide is threaded into an aluminum angle bracket, and the cable end terminates in a turnbuckle.
- Mount two springs in front of the rudder pedals to keep them from falling backwards when the pilot's feet are removed. Access for hooking up springs or adjustment is through inspection hole in nose.
- Adjust elevator cable to give approximately 25°-30° up and 10°-15° down elevator travel.

#### WING RIBS AND RIB FIXTURE

The Wright Brothers undoubtedly used some type of rib fixture to assemble their wing ribs, and so has nearly everyone since. Much has been written about how to do this, and you may have your own pet method. If so, use the method that best suits you. A fixture may be as simple or as complex as you wish. The one described here is probably a bit above average.

- Obtain a board about 10" by 60" by 1/2" to 3/4" thick. Particle board shelving, available at most building supply houses, is preferred over wood boards, since it does not tend to curl or bow. The board must be flat.
- Place the full size drawing on the surface and tape down.
- Over this, put a sheet of thin transparent plastic. Wax paper will do, but not very well. Staple it down and rub on two coats of paste wax.
- At the bottom edge of the rib, nail down a straight length of RS-6 strip. Use a metal straight edge for accuracy.
- Cut more lengths of RS-6 and locate where shown. Do not drive nails all the way in, in case the piece must be moved for alignment. Note that the locating strips must have the ends cut at angles to permit gussets to fit.
- The "cam action" fasteners shown are a simple, quick method of holding parts in position. Just cut short lengths of wood dowel and drill slightly off center.
- Place a length of 1/4" square rib stock, RS-1, in place on top of rib drawing and check curve. Adjust locating blocks until wood cap strip follows drawing smoothly.
- Cut 1/16" (or 1.5 mm) thick gussets to the appropriate length as shown on the rib drawing. Two methods may be used. The ends may be left square, which is simplest and quickest, or you can save a little weight and material by cutting ends at the angles shown. Gussets may be cut one at a time with ordinary tin snips or a modelers saw. To cut many at one time, nail up a "U" channel mitre box and stack several strips at once. This method also works well for the 1/4" square rib parts.
- Cut the 1/4" square vertical and diagonal parts and the upper and lower cap strips to length and place in the fixture. The diagonal members may have square cut ends, since the gussets support all the load in shear. The front end of the upper cap strip must be extended about 4" forward. This is only required until the glue dries, after which it is cut off and used on another rib for verticals or diagonals.
- Glue the 1/4" square doublers near the rear part of the rib to the upper and lower cap strips as shown. Part of the cap strips will be cut away when the ailerons are separated. This is the reason that these doublers are glued for only a part of their length. Glue and staple the gussets to the upper side of the rib. The drawing shows the location and number of staples used on each gusset.
- After gluing and stapling gussets on one side, carefully remove rib from fixture. Lay gusset side down on bench and glue and staple on another set of gussets directly opposite the lower set.
- After glue has cured, cut front cap extension off and sand off edges of gussets that may extend outside of caps.
- Take the first sanded rib and check it against the drawing. If it is out of line or mis-curved, adjust the fixture as necessary.
- With everything working properly, you can assemble a rib in as little as 20 minutes. After the glue has cured, the staples should be pulled, both to save weight and to prevent rust from weakening the joint.
- Root and tip ribs will have one side completely covered with plywood. Since right and left hand sides are required, one end rib may have the plywood stapled on after removing from fixture, but the other requires that the first set of gussets be stapled in place without glue. Only glue the ends of the 1/4" square strips. Remove gently from the fixture and glue and staple on the second set of gussets. Now turn over, remove the unglued gussets, and replace with the plywood sheet. Note that root and tip ribs have 1/8" thick plywood on ends of wing, but aileron ends are 1/16" plywood.
- Make up 20 standard ribs and two each of the right and left end ribs, for a total of 24 ribs. Dwg. 16 shows rib numbers for all ribs except root and tip ribs.

17. Each end rib requires that three 1/4" pieces of plywood be glued in for reinforcement. This is also true for rib #5 (see drawing 13).

- Next glue the 5" long pieces, cut from RS-9, to both root and tip ribs. They are for mounting bearings and aileron horns.
  - Mark aileron end covers with exact centerline of pivot point, per the rib drawing. Drill a 1/4" hole through rib on pivot point, per drawing 13, section A-A.
  - Bolt end of bearing bracket through this hole. With bracket parallel to bottom of rib, drill the two 3/16" mounting holes. Insert two AN3-6A bolts and thread on the anchor nuts. Mount the nuts permanently with small wood screws.
  - Rib #5 is used as a center bearing support for the aileron. Install another bearing bracket as on end ribs.
  - Bearing brackets may be left on ribs throughout wing assembly. They will support the aileron as it is cut away from wing.
- WING SPARS
- Both spars are built up on the work bench, using the same "straight-edge" strip used for the fuselage. Build the main spars first (See dwg. 14):
- Locate the specially selected and marked spar caps. Place the lower spar cap, RS-9, against the reference strip. Measure and mark the location of all vertical compression members on the cap.
  - Cut these vertical members from RS-5 and RS-9 and locate on the lower cap.
  - Place the top RS-9 spar cap over these verticals.
  - At the root end cut and fit the RS-8 members.
  - Cut the diagonal member from RS-11 and install near the center of the spar.
  - Note that the root is angled at 3 degrees so the root rib will fit flush against the fuselage.
  - Before gluing, place a strip of wax paper under the spar to prevent the assembly from sticking to the bench.
  - Glue all members between the upper and lower caps. Nail small blocks into bench top to hold caps in place.
  - Cut spar webs, RS-538, to length, and glue to caps and verticals.
  - After glue is dry, the top edge of the upper cap must be cut at 10-1/2 degrees, per the drawing. This is best done on a table saw, but it can be done with a plane.
  - Cut plywood strips from RS-561 for assembly at wing center (at diagonals) and at root. Note that these are installed on both sides of spar.
  - When laying up parts for the second spar, be sure to make (1) right hand and (1) left hand spar, and also be sure you cut the 10-1/2 degree angle on the correct side. This is an easy mistake to make!
  - Fittings are cut from RS-100 aluminum bar.
  - Locate fittings on spar and drill. This is best done on a drill press if available. One way to insure that the root fittings will be exactly 2-3/16" from the root end is to cut a scrap wood block 1" by 2-1/2" by about 6" long. Near one end, drill a 1/4" hole exactly 2-3/16" from the edge. Place fittings on each side and insert bolt. Hold the block against the root end to mark and drill mounting holes in spar.
  - Remove the fittings and varnish the wood underneath. After the varnish is dry, permanently install the main spar fittings.
  - The rear spar assembly is almost identical to the front, except the upper cap has a RS-8 doubler in the area of the diagonal.
  - After the glue has cured, the rear spar is also bevel cut at 10-1/2 degrees. Again, be careful to cut the bevel on the correct side.
  - Note, RS-561 strips at root are not permanently glued into place until ribs are installed. Fittings are also not permanently installed until the wing is assembled.

#### WING ASSEMBLY

Before the wing can be assembled, several details must be attended to.

- Cut the front end of all rib caps flush with the vertical member, sand smooth but do not sand away any of the vertical.
- Lay the rib on a board or bench top and nail a strip along bottom edge of rib into board. Cut a 8" length and nail at trimmed front end of rib. This strip should be at a 90 degree angle to the first.
- The trailing edge cut off point is 46 inches from this vertical member. See full size rib drawing.
- Cut all ribs at this length. On plywood covered root and tip ribs, cut only the 1/4" square caps, not the plywood. The plywood should extend beyond the rib trailing edge.
- Be sure all rib gussets are sanded flush with the outer edge of caps.
- Test slide ribs onto rear spar to ensure the opening is not too tight.
- Place the front spar (right side up) on bench top with web side against the wood strip fence. Hold in place by nailing small blocks into bench.
- Set rear spar on bench and slide on rib #5 from root end. Next, rib #6 from tip end, rib #4 from root, etc.
- Use small spring clamps or spring type clothespins to hold rib verticals to spar during assembly.
- On rib drawing, note location of nails that hold rib to spar while glue dries. Pre-set nails into rib before gluing. Where diagonals prevent using a tack hammer, hold nail with needle nose pliers and tap nail into wood by hitting on plier jaws.